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## UNISYS

To λ. Sharma

Department Code 311

K. Sahu 🛌

Department 7809

Subject
Radiation Report on GPEP
Part No. AD7541ATQ
(Control No. 3800)



Interoffice Memorandum

PPM-91-710

)ate

December 30, 1991

Location

GSFC

Telephone

731-8954

Location

Lanham

CC

S. Archer-Davies

T. Perry

Library/311

A radiation evaluation was performed on AD7541 to determine the total dose tolerance of these parts. A brief summary of the test results is provided below. For detailed information, refer to Tables I through V and Figure 1.

The total dose testing was performed on twenty-four parts using a cobalt-60 gamma ray source. The twenty-four parts were separated into two test groups (TG1 & TG2) of twelve parts each. In addition, two other parts were used as control samples. Before radiation testing began, all 26 parts were electrically tested according to the test conditions and specification limits listed in Table III, at temperatures of -55°C, 25°C and 125°C.

Parts in Test Group 1 (TG1) were tested after total dose exposures of 2.5, 5, 10, 15, 20, 30, 50, 75 and 100 krads\*. The dose rate was between 0.1 to 1.3 krads/hour, depending on the total dose level (see Table IIA for the radiation schedule of TG1). After the final radiation exposure to 100 krads, six parts in TG1 were annealed at 25°C under bias and the other six parts were annealed at 25°C unbiased. During annealing all parts in TG1 were tested at cumulative annealing times of 4, 24, 168 and 672 hours.

All twelve parts in TG1 passed all tests to 2.5 krads. At 5 krads ten parts failed to meet the minimum specification limit for IZS1 (the lowest reading was -130nA versus the minimum specification limit of -50nA). At 10 krads, all parts in TG1 failed IZS1 and failed to meet the maximum specification limit of 100uA for IDD1 (readings ranged from 480uA to 7mA). Also, ZERO1 and GAIN1 readings for all parts were way beyond the specification limits. In addition to the above failures, all parts failed IZS2 at cumulative exposures to 15, 20, 30, 50, 75 and 100 krads. One part recovered to pass IDD1 after 696 hours of annealing; however, all other parts continued to fail the above tests. Table IV provides the mean and standard deviation for each electrical parameter at selected steps of TG1 testing.

The radiation exposure to parts in Test Group 2 (TG2) was limited to a single total dose of 5 krads, as the TG1 results showed significant degradation in this part type at this exposure level.

The dose rate was much higher for TG2 - 5.0 krads/hour compared to 0.1 krads/hour used in irradiating the TG1 parts to 5 krads (see Table IIB for radiation schedule). All twelve parts were then annealed at 100°C for 168 hours. Six of the twelve parts were tested at 25°C at cumulative annealing times of 4 and 24 hours. All twelve parts in TG2 were tested at -55°C, 25°C and 125°C after 168 hours of annealing.

All twelve parts in TG2 passed initial electrical measurements. On exposure to 5 krads, all parts exceeded the maximum specification limit for IZS1. IZS1 readings ranged from -94 to -531nA. Of the six parts which were tested after 4 and 24 hours of annealing, two and three parts (respectively) passed all tests. During final annealing measurements (168 hours), all parts passed all tests at -55°C, seven parts passed all tests at 25°C, and all parts failed IZS1 at 125°C (in addition to IZS2 and IDD2 failures). Table V provides the mean and standard deviation for each electrical parameter at each step of TG2 testing.

The effect of dose rate was evident on comparing IZS1 measurements of TG1 & TG2 parts. At 5 krads total dose, the average IZS1 over the 12 parts in TG2 (irradiated at 5 krads/hour) was approximately three times higher than the same average for the 12 parts in TG1 (irradiated at 125 rads/hour). Also, note that the parts in TG2 recovered well when allowed to anneal immediately after failure at 5 krads, whereas parts from TG1 showed no significant recovery on annealing after 100 krads of irradiation.

Any further details about this evaluation can be obtained upon request. If you have any questions, please call me at (301) 731-8954.

<sup>\*</sup> In this report, the term "rads" is used as an abbreviation for rads (Si).

### TABLE I. Part Information

Generic Part Number: AD7541

GPEP/PPL

Part Number: AD7541ATQ

GPEP/PPL

Control Number: 3800

Charge Number: C13919

Manufacturer: Analog Devices

Lot Date Code: 9040

Quantity Tested: 26

Serial Numbers of 201, 202, 203, 204, 210, 211 (TG1) Radiation Samples: 212, 213, 214, 215, 216, 217 (TG1)

> 206, 207, 208, 209, 218, 219 (TG2) 220, 221, 222, 223, 224, 225 (TG2)

Serial Numbers of Control Samples:

ontrol Samples: 200, 205 (TG1 & TG2)

Part Function: 12-Bit DAC

Part Technology: CMOS

Package Style: 18-Pin DIP

Test Engineer: C. Nguyen

TABLE IIA. Radiation Schedule for TG1

EVENTS	DATE
1) Initial Electrical Measurements at -55°C, 25°C and 125°C	05/15/91
	06/04/91 06/05/91
	06/05/91 06/07/91
	06/07/91 06/10/91
	06/10/91 06/11/91
	06/11/91 06/13/91
	06/13/91 06/14/91
	06/14/91 06/17/91
	06/17/91 06/18/91
	06/18/91 06/19/91
	06/19/91 06/19/91
	06/19/91 06/20/91
	06/19/91 06/26/91
	06/19/91 07/18/91

#### Notes:

- All parts were radiated at the cobalt-60 gamma ray facility at GSFC.
- All electrical measurements were performed off-site at 25°C, unless otherwise noted.
- Annealing performed at 25°C under bias for 6 parts, at 25°C unbiased for other six parts.

Table IIB. Radiation Schedule for TG2

EVENTS	DATE
1) Initial Electrical Measurements at -55°C, 25°C and 125°C	05/15/91
2) 5 krads irradiation @ 5 krads/hr	09/16/91
Post 5 krads Electrical Measurements	09/17/91
3) 4 hour annealing	09/17/91
Post 4 hr Electrical Measurements (6 parts)	09/17/91
4) 24 hour annealing	09/17/91
Post 24 hr Electrical Measurements (6 parts)	09/23/91
5) 168 hour annealing Post 168 hr Electrical Measurements at -55°C, 25°C and 125°C	09/17/91 09/24/91

#### Notes:

<sup>-</sup> All parts were radiated at the cobalt-60 gamma ray facility at

<sup>Annealing performed at 100°C under bias.
All electrical measurements were performed off-site at 25°C, unless otherwise noted.</sup> 

Table III. Electrical Characteristics of AD7541

 $V_{\mathrm{DD}}$  = 15V,  $V_{\mathrm{REF}}$  = 10V, OUT1 = OUT2 = 0V, unless otherwise specified.

 $T_A = 25^{\circ}C$ 

Parameter	Test Conditions	Min	Max	Unit
IIL	V <sub>IL</sub> = 0V	-1	1	uA
I <sub>IH</sub>	V <sub>IH</sub> = 2.4V	-1.	1	uA
I <sub>ZS1</sub>	V <sub>IL</sub> = 0.8V	-50	50	nA
I <sub>ZS2</sub>	V <sub>IH</sub> = 2.4V	-50	50	nA
IREF_POS	$V_{IH}$ = 15V, $V_{REF}$ = 10V	0	0.5	πA
I <sub>REF_NEG</sub>	$V_{IH} = 15V, V_{REF} = -10V$	-2	0	mΆ
I <sub>DD1</sub>	$V_{IL} = 0V, V_{IH} = 15V$	0	0.1	mA
I <sub>DD2</sub>	$V_{IL} = 0.8V, V_{IH} = 2.4V$	0	2	mΛ
Gainl		-407	407	m%FS
LIN	$V_{IH} = 15V$ , $V_{IL} = 0V$	-	12.2	m%FS
D LIN	$V_{IH} = 15V$ , $V_{IL} = 0V$	_	12.2	m%FS
dFS1+		_	10	m%
ZERO1 *	1 11 11 11 11 11 11 11 11 11 11 11 11 1	····		

<sup>\*</sup> No specification limits for ZERO1 were provided by the manufacturer.

Spec. Limits										Total	1 Dose	l I	Exposure	1 1	(krads)				Anneal	eal
Name		m D	ec. L @25°	1mits C	Pre.	Rad	73	ស្	S.		10	_	20		20		100	_	696 @2	696 hrs
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Parameter			пах	mean	s Q	mean	S G	mean	Вđ	mean	54	mean	e G	mear.	sd	mean	3Ġ.	mean	8đ
uA         -1         1         0		L.	  -	1	0		0	0	o	0	0	٥	0	0		O	J.	0	0	0
na -50 50 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	LIH	ļ	ļ -		0	٥	0	0	0	0	0	0	0	0	0	0	_0	0	0	0
POS         uA         − 50         50         0         0         0         0         −30         7         −425         78         −515         20         −664           POS         uA         0 <td>12S1</td> <td><u>L</u>.</td> <td>50</td> <td>50</td> <td>0</td> <td></td> <td>0</td> <td>0</td> <td>76</td> <td>32</td> <td>+EE5</td> <td>2E4</td> <td>539-</td> <td>2E4</td> <td>539-</td> <td>2E4</td> <td>-7E5</td> <td>2E4</td> <td>-785</td> <td>2E4</td>	12S1	<u>L</u> .	50	50	0		0	0	76	32	+EE5	2E4	539-	2E4	539-	2E4	-7E5	2E4	-785	2E4
POS         uA         0         500         94         2         95         1         102         2         102         4         102         4         102         4         102         4         102         6         10         6         6         10         6         6         10         6         6         10         6         6         10         6         7         6         6         7         7         7         7         7         7         7         7         7         7 <td>1252</td> <td><b>.</b></td> <td>50</td> <td>50</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>-30</td> <td></td> <td>-425</td> <td>7.8</td> <td>-615</td> <td>20</td> <td>-664</td> <td>7.2</td> <td>699-</td> <td>20</td>	1252	<b>.</b>	50	50	0	0	0	0	0	0	-30		-425	7.8	-615	20	-664	7.2	699-	20
NEG   mA   -2   0   -0.6   -0.6   0   -0.6	IREF POS	_	j	500	7.6	~1	76	2	56		102	2	102	7	101	4		3	112	3
uA         C         100         0         0         0         4E3         2E3         1F3         1E3	IREF_NEG		-2	0	9.0	0	9:0-	0	9.0-	0	9*0-	0	- 0.6	0	9.0-	Û	9.0-	0	9 0 -	0
2 mA C 2 (0.12) 0.1 0.4 0.1 0.8 0.1 0.95 0.05 0.05 0.86 0.1 0.83 0.07 0.83 0.07 0.83 0.07 0.83 0.07 0.83 0.07 0.83 0.07 0.83 0.08 0.1 0.85 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1	IDCI	_	ت	100	1 1 1 1 1 1 1	0	0	0	0	0	₫ <b>E</b> 3	2E3	1.03	129	1.83	129	123	82	733	221
N 1         m% FS         -407         407         407         407         407         168         14         156         49         -1ES         0	2dCI	_	j	1,41	0.2	0.1	0.4	0.1	8 0	0.1		0.05	98.0			0.07		0.07	0.82	0.07
m%FS         -         12.2         5.5         1.4         3.4         0.8         3.4         0.7         -0.6         0.2         -0.4         0.3         3.4         0.8         4.5           IN         m%FS         -         12.2         2.4         0.8         2.6         1.0         -0.4         0.1         N/A         5.3         1.2         6.8           1+         m%         -         10         0.4         0.0         -0.3         0.5         -0.1         N/A         0.2         -0.4         0.1         -0.4         0.2         -0.4         0.2	<b>-</b> -1	⊢	107	407	206	15	168	14	156	49	-1ES	0	-125	0	541-	0	-1BS	0	-1E5	0
m%FS - 12.2 2.4 0.8 2.6 0.9 2.6 1.0 0.4 0.1 N/A 1.1 1E5 0.1 0.2 -0.8 1.2 6.8 m%FS see note 4 -0.7 0.1 +0.1 0.1 0.2 1.4 1.1 1E5 0 1E5 0 1E5 0 1E5				12.2	5.5	7	3.4		3.4	0.7	-0.6	0.2	=0.4	0.3	3.4	-	4.5	1.2	5.2	1.1
m% - 10 0 4 0.5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0				12.2	2.4	0.8	2.6	6.0	2.6	0	-0.4	0.1	N.7.A		5.3	•	6.8	2.3	8.5	2.0
m%7S see note 4 H007 0.1 H011 0.2 114 1.1 1155 0 1155 0 1155 0	dFS1+		1		₽ 0	1 1	0.0	0.0	-0.3	•	-0.3	0,2	.0	0.1	<b>₽.</b> 0	0.2	9 0-	0.4	• •	0.3
	ZERO1 m%	Ш	88 no	4	4.0	0.1	<b>-0</b> -1	0.2	7.1	[-]	123	0	165	0	185	0	1E5	0	1E3	٥

1/ The mean and standard deviation values were calculated over the twelve parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.
2/ Table IV provides radiation characteristics of parts at selected total dose exposures and annealing 3/ SNS 201,202,210,211,212, and 213 were biased during annealing and SNS 203,204,214,215,216 and 217 were not. Because there was no significant recovery in any of the parts during annealing, Table IV provides the mean and standard deviation calculated over all twelve parts at the final annealing step. 4/ No specification limits for ZEROI were provided by the manufacturer. 2/ Table IV provides radiation characteristics of parts at selected total dose exposures and annealing treatments. The data at other radiation exposures and annealing treatments is available and can be cbtained upon request.

Spec.*   Pre-Irradiation   TDE   100°C Annealing   168 hrs   168			၁		H		-4	٦		N		-1	-	0	0	m	O
Spec.*   Pre-Irradiation   TDE   100°C Annealing   168 hrs   18, 25°C   EM @25°C   EM			125	βg	.01	٥	854	59		. 02		1:1	260	800	800	8E3	270
Spec.*   Pre-Irradiation   TDE   100°C Annealing   168 hrs   150°C Annealing   168 hrs   150°C   168 hrs   150°C   168 hrs				пеап	70	o	-424	-220	7.8	9 0	o	θ×0	0.4	243	241	583	189
Spec.*   Pre-Irradiation   TDE   100°C Annealing   168   25°C   EM @25°C	:	rs	-55°C	sd	.02		*	٥		. 02	¢	6.0	ω	8.0	4	0.4	1.3
Spec.*         Pre-Irradiation         TDE         100°C Annealing           Limits         BK 025°C         EW 0-55°C         EW 0125°C         Frads         4 hrs         24 hrs         24 hrs           \$25°C         nin max         mean         8d         mean         8d         nean         nean	!	168 h		mean		101	Ţ	٥	108	±0.6	9	1.0	224	4.0	3.1	-08	1.4
Spec.* Pre-Irradiation TDE  Limits BW @25°C EW @-55°C EW @125°C FRrads 4 hrs 24  a 25°C	ling	-	2°6	sđ	0	0	127	0	į	.02	0	0.4	в	0.6	0.8	0.2	0.2
Spec.* Pre-Irradiation TDE  Limits BW @25°C EW @-55°C EW @125°C FRrads 4 hrs 24  a 25°C	Annea			mean	0	•	-94	0	16	-0.6	0	0.2	161	4.0	2.2	<b>_0</b> .2	0.1
Spec.* Pre-Irradiation TDE  Limits BW @25°C EW @-55°C EW @125°C FRrads 4 hrs 24  a 25°C	J.00	rs	2°C	pg	0	o	4.0	O.		.02		0.3		0.4	9.0	0.2	0
Spec.* Pre-Irradiation TDE A hrs & 25°C EW @125°C S Krads A hrs & 25°C min max mean sd	1,0	•		теап	Q	0	. ₽S=	0	100	9.0-	a	0.2	201	4.0	3.2	-0.5	1.1
Spec.* Pre-Irradiation TDE  Limits		LS	2,6	ಕ್ಷಣ	60			J		CII	(3)	0.5	wo	4.0	0.4	0.2	2.0
Spec.* Pre-Irradiation TDE  Limits EW @25°C EW @-55°C EW @125°C 5 Krads  ### ### ### ### ### ### ### ### ### #	1			mean	9	0	1.82	o	101	9. Q-	c	9 0	1.88	-1 -1	3.2	<b>5</b> 0-	6.
Spec.*  Limits	同	ads	2005		0	٥	109	O	y.	.02	o			8.0	1.2	1.1	5.0
Spec.*  Limits	T <sub>D</sub>	5 Kr		теап	0	0	+317	٥	9.7	9.0-	٥	1.1	170	n	3.7	-3.0	1.0
Spec.*  Limits		25°€	<u>-</u>	3¢	. 60	9.0	259	11	-	.02	0	0	10.0	2.0	1.0	0.4	2.2
Spec.*  Limits	c			пеап	10	₽0.	-76	-10	8.2	9.		0.2	222	6.4	2.9	e * 0	8.2
Spec.*  Limits EW @	atio	.55°C			1 .		45	5	9	.02	0	80.	23		2.5		4.6
Spec.*  Limits EW @	rradi	EK @		пеап	10**	10.	22	Ä	107	•	0	ۍ 0	1.62	5.5	69 69	2-0-	5 5
Spec.*  Limits EW @	Pre-I	60		99	٥	0	٥		Ī			l	<u> </u>				0.1
Spec.*  Limits				mean	0	0		0		9 0-	0	270	206	3.5	2	₹:0-	-0°2
Signature (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	* :		5,00	max	-		5.0	50	500		100	2	407	12.2	12.2	10	te 3
	Spe	Limi	69	min 1		-1	-50	-50		7		0	1			ı	see note
# [ [ 기 기 기 기 기 기 원 활] 활 기 생					ďņ	u.A.	A C	A.C.	μ'n	A.P.	1	a' A	m&FS	m&FS	田等下窓	æ Fi	m%FS s
NEG NEG				aranet	1.	   #1	:81	182	SOE EST	RF NEG	101	302	_			+ + 18:	ZEROI n

# Notes:

1/ The mean and standard deviation for pre-irradiation electrical measurement data was taken over The mean and standard deviation for all post-radiation and 2/ All twelve irradiated parts were annealed for 168 hours; however, only 6 of 12 (SNs annealing measurements were calculated only over irradiated test samples. both test groups and control samples.

mean and standard deviation for the 168-hour annealing measurements were taken over all twelve parts 206,207,218,219,220 and 221) parts were tested at 4 and 24 hours during the 168-hour annealing. The mean and standard deviation values at these steps were calculated over these six parts. because the measurement data was vary similar over all twelve parts.

3/ Specification limits for ZEROl were not provided by the manufacturer

\* The maximum specification limits for IZS1,2 at high and low temperature electrical measurements (EM) are ±200nA

Figure 1. Radiation Bias Circuit for AD7541

